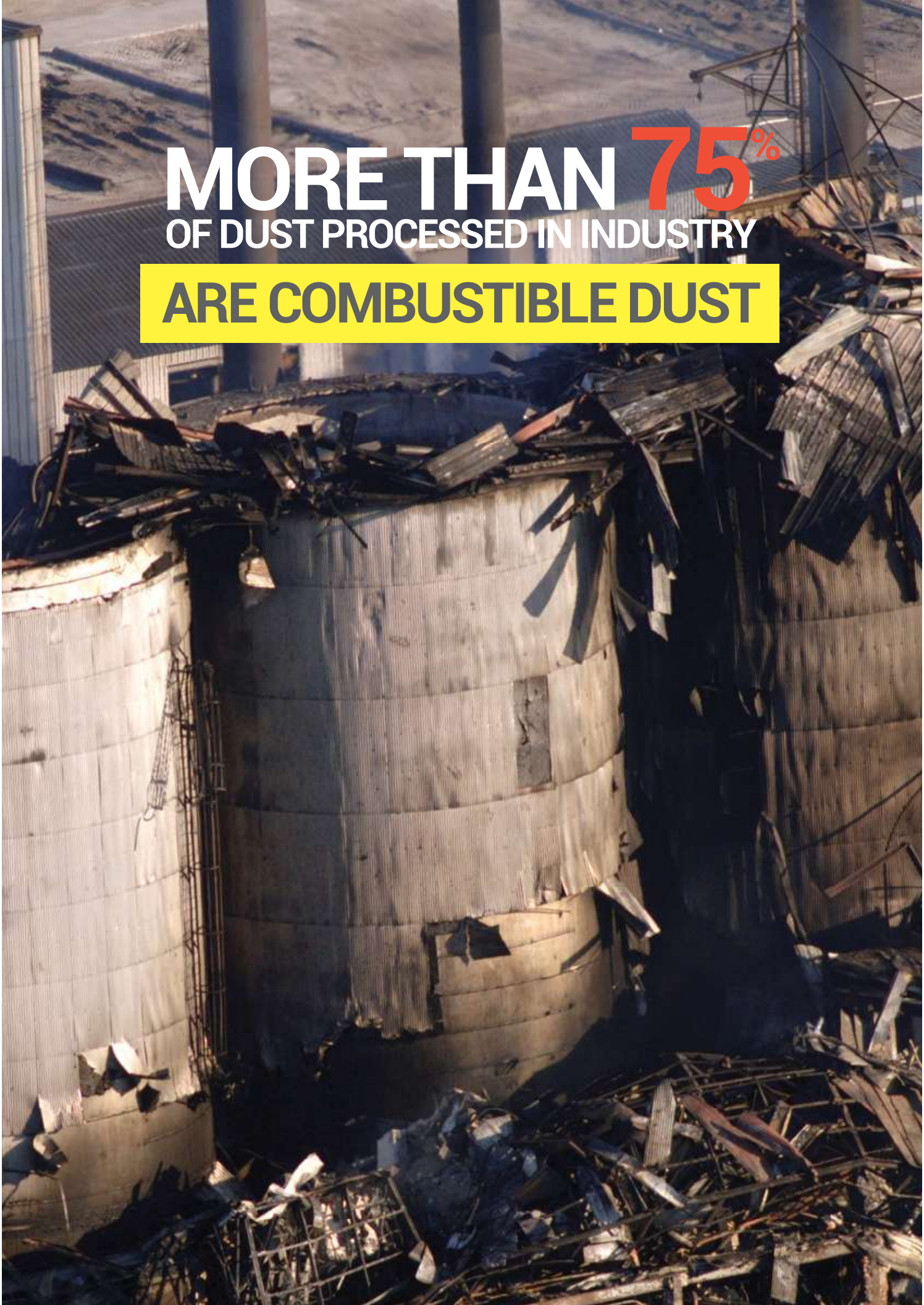
DUST EXPLOSION AND RISK AT WORK PLACE

PETROLEUM SAFETY DIVISION
DEPARTMENT OF OCCUPATIONAL SAFETY AND HEALTH


MORE THAN 75%
OF DUST PROCESSED IN INDUSTRY
ARE COMBUSTIBLE DUST

IF DUST ACCUMULATION IS NOT CONTROLLED, IT CAN CAUSE

DUST EXPLOSION

Imperial Sugar Dust Explosion Accident
Georgia USA - 2008

WHAT STANDARD SAYS ABOUT DUST?

NFPA®

Dust = Any finely divided solid (Diameter ≤ 420µm)

bsi.

BS 2955: 1958

Powder if (Diameter < 1000µm: 16 BS *mesh size*)

bsi.

BS 2955: 1958

Dust if (Diameter < 76µm: 200 BS *mesh size*)

BSi = British Standard Institution

NFPA: National Fire Protection Association

BS 2955:1958: revised & withdrawn with BS 2955: 1993

COMBUSTIBLE DUST

Starch, wheat
Whey
Egg white

AGRICULTURAL PRODUCTS

Sugar, beet
Sugar
Tapioca
Starch, rice
Wood flour
Sugar, milk
Milk, nonfat, dry
Soy flour
Starch, corn
Milk, powdered
Sodium stearate
Carboxy-methylcellulose
Paraformaldehyde
Methyl-cellulose
Dextrin
Sodium ascorbate

CHEMICAL DUST

Lead stearate
Sulfur
Ascorbic acid
Calcium stearate
Calcium acetate
Lactose
Adipic acid
Anthraquinone

METAL DUST

Magnesium
Aluminium
Bronze
Iron carbonyl

CARBONACEOUS DUST

Peat, 22%H20
Lampblack
Cellulose pulp
Corn
Cellulose
Charcoal, activated
Coal, bituminous
Charcoal, wood
Cork
Soot, pine
Lignite
Coke, petroleum

Peanut meal and skins
Potato starch
Locust bean gum
Rye flour
Gluten
Cornstarch
Xanthan gum
Green coffee
Carrageen
Garlic powder
Sugar (10x)
Oat grain dust
Wheat starch
Wheat grain dust
Oat flour
Grass dust
Malt
Sunflower seed dust
Cotton
Cocoa powder
Tobacco blend
Wheat flour
Alfalfa
Potato
Linseed

AGRICULTURAL DUST

Sunflower
Peach
Apple
Coffee dust
Rice flour
Semolina
Tomato
Tea
Cottonseed
Rice dust
Soybean dust
Spice powder
Peat
Corn meal
Carrot
Beet root
Spice dust
Lemon peel dust
Olive pellets
Raw yucca seed starch
Potato flour
Coconut shell dust
Parsley (dehydrated)
Hops (malted)
Lemon pulp
Walnut dust
Onion powder
Cocoa bean dust

(poly) Vinyl chloride / ethylene / vinyl acetylene suspension copolymer
Terpene-phenol resin
(poly) Methyl acrylate
(poly) Acrylamide
(poly) Acrylonitrile
(poly) Vinyl chloride / vinyl acetylene emulsion copolymer

(poly) Ethylene – low pressure process

PLASTIC DUST

(poly) Propylene
Melamine, resin
Epoxy resin
(poly) Vinyl alcohol
Melamine, molded (phenol-cellulose)
(poly) Vinyl acetate / ethylene copolymer
(poly) Vinyl butyral
Urea-formaldehyde / cellulose, molded
(poly) Methyl acrylate (emulsion polymer phenolic resin)
Melamine, molded (wood flour and mineral filled phenol-formaldehyde)

What type of combustible dust do you have in your factory?

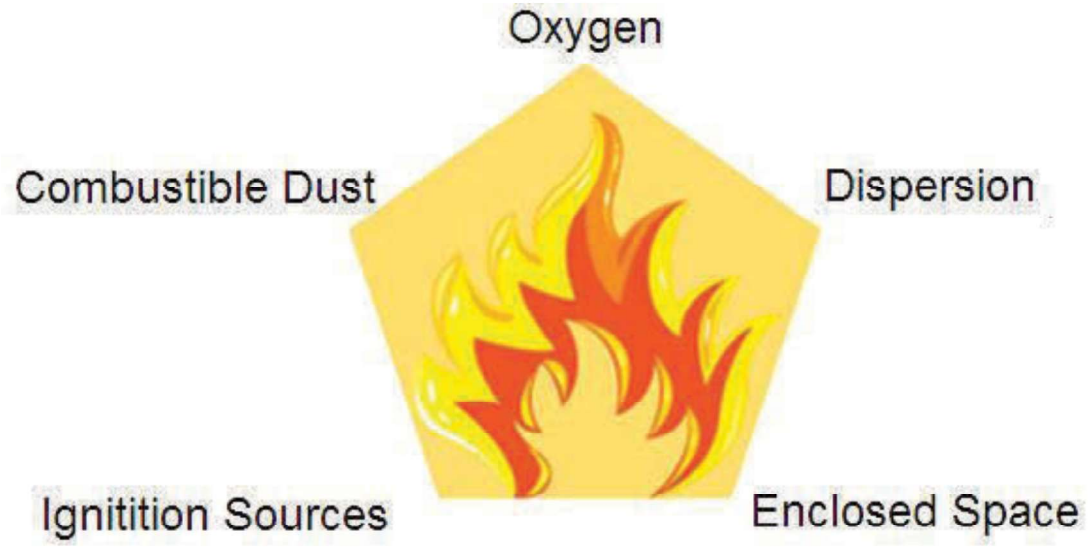
INDUSTRIES PRONE TO DUST EXPLOSION

Your factory falls in which category?

Which OPERATION can produce DUST

DUST EXPLOSION THEORY

A dust explosion is initiated by the rapid combustion of flammable particulates suspended in air. If the ignited dust cloud is unconfined, it would only cause a flash fire. But if the ignited dust cloud is confined, even partially, the heat of combustion may result in rapid development of pressure, with flame propagation across the dust cloud and the evolution of large quantities of heat and reaction products. The furious pace of these events results in an explosion that can destroy buildings, plant and injured humans.



Dust explosion cannot occur if ONE of the above sources does not present

Enclosed Space

Dust Explosion will only happen within equipment or structure enclosure. When the dust cloud is contained within a closed area, which can be as large as warehouse or factory, it causes issues with confinement. Dust particles can remain suspended in confined air for days, causing the density of the dust cloud to be constantly increasing. When the dust cloud combusts, the confinement will cause intense pressure to build and push the explosion through every corner of the facility.

Oxygen

Oxygen affect process dust explosion to a level that is very severe. The concentration of oxygen in the air that exceed 21% will increase the velocity of the combustion of the fuel. The fire will continue when the concentration of oxygen in the air is more than 10%.

Dispersion

This is when the accumulated dust is spread out over the air and creates a dust cloud. This can be caused when daily activities disturb accumulated dust and sent it airborne, such as sweeping, exhaust from machinery or cleaning using compressed air. Another cause of dust dispersion is when a small primary combustion occurs and sends shockwaves throughout the facility. These shockwaves can knock down dust that had settled on rafters, pipes or HVAC ductwork and spread it throughout the air. Once it has been dispersed this dust can change from the initial fire to an explosion almost immediately.

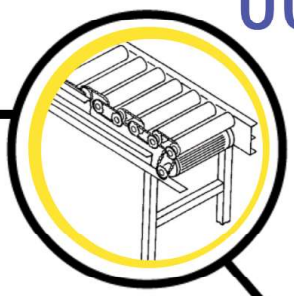
IGNITION SOURCE

001. MECHANICAL / HOT WORKS

INVOLVE FRICTION PROCESS

- Friction can produce sparks.
- Friction increases the temperature of dust particles nearby mechanical / hot works area.
- Examples of mechanical / hot works: knocking, welding, cutting, grinding etc.

002. ELECTROSTATIC



INVOLVE ELECTROSTATIC PROCESS

- Electrostatic can produce sparks.
- Electrostatic charge created by fast moving object on certain materials (electrostatic).
- Examples of works activities which involved: belting, conveyors, pneumatic system etc.

003. SELF HEATING

INVOLVE SELF HEATING / SPONTANEOUS FIRE DUE TO REACTION

- Example of reactions: Oxidization and/or certain reaction like dust with water or woods.
- Rate of reaction dust + temperature + self heating will accelerate the event of dust explosion.
- Cause: Catalyst or inhibitor removal will withdraw during the reaction.
- Contributor of self heating: Impurities such as oil and heat degradation products.

004. ELECTRICAL SPARKS

INVOLVE ELECTROSTATIC CHARGE FROM ELECTRICAL APPLIANCES

- Electrostatic charge from electrical appliances can produce sparks.
- Examples of electrostatic charge mechanism: ignition in switch or impedance of electrical appliances.

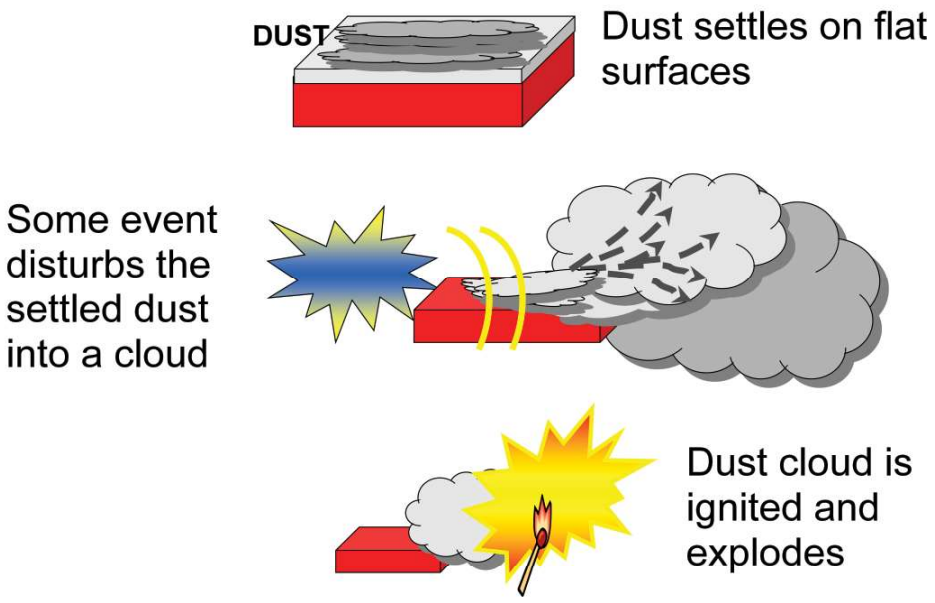
PRIMARY EXPLOSION

The first / initial blast that usually occurs in :

(i) Dust collection system

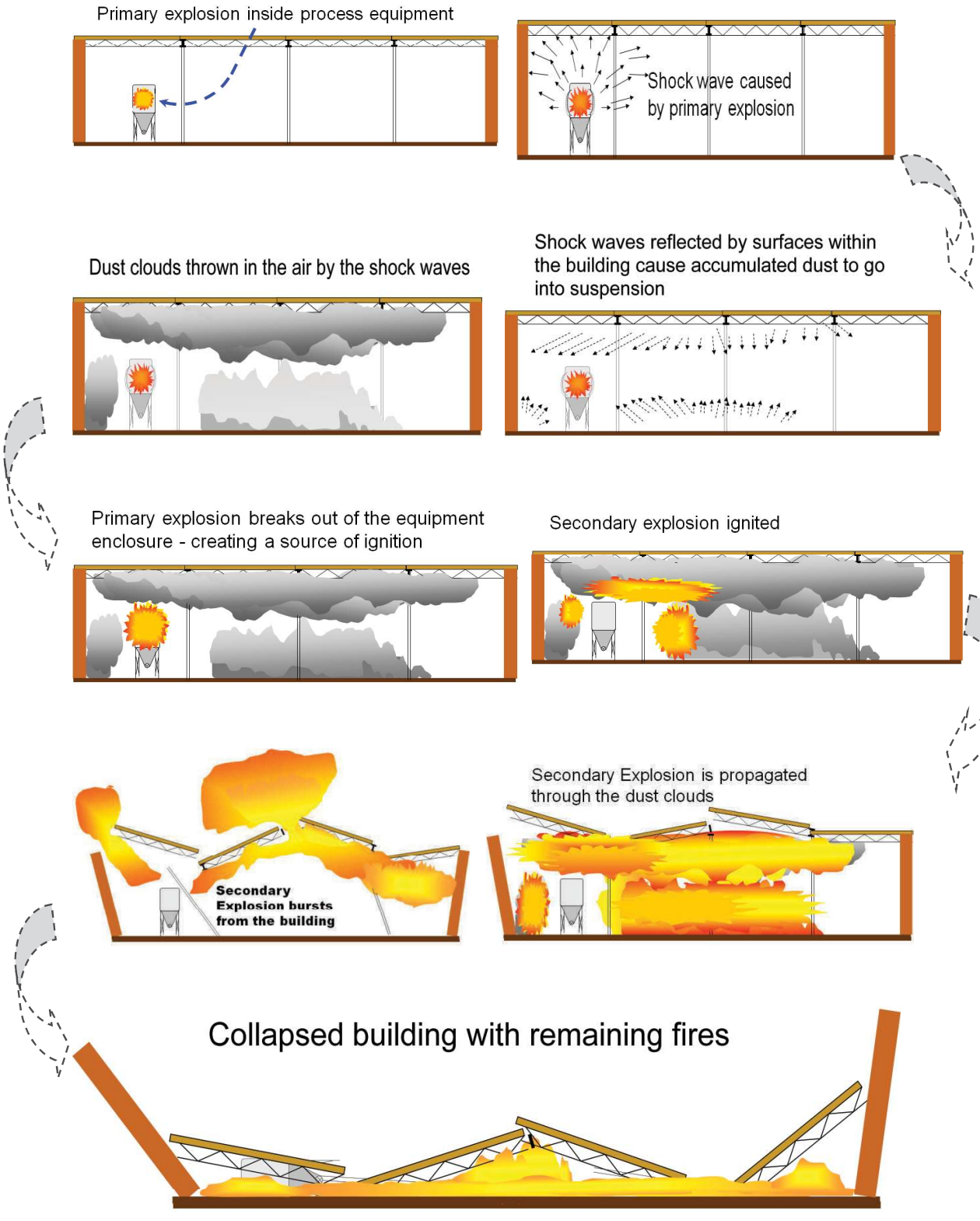
(ii) Machine/ processing machinery (eg: dryer, cyclone, hopper, filter, bucket elevator, aspiration duct and pneumatic transit system)

which formed dust cloud or a small area where the accumulated dust disturbed, blown and dispersed into the air to form a cloud / dust cloud.



SECONDARY EXPLOSION

Shockwave from primary explosion will disturb the layer of dust deposited in the surrounding area and will fly as well as the dust disperse into air. Clouds of dust and larger will be formed. Heat loss due to the first explosion would be material to a flame or spark new dust cloud. Finally the secondary explosion which could be WORSE than the first explosion.


Primary explosion inside process equipment
Shock wave caused by primary explosion
Shock waves reflected by surfaces within the building cause accumulated dust to go into suspension
Dust clouds thrown in the air by the shock waves
Primary explosion breaks out of the equipment enclosure - creating a source of ignition
Secondary explosion ignited
Secondary Explosion is propagated through the dust clouds
Secondary Explosion bursts from the building
Collapsed building with remaining fires

DUST EXPLOSIONS

WORLDWIDE

Dust Explosion Info

Year 2008

14 FATALITIES

IMPERIAL SUGAR COMPANY

38 injured

AGRICULTURAL DUST

Up to Year 2014

15 *cases*

192 *fatalities*

179 *injuries*

18 CASES

Silo/Bin/Storage

33 Killed

53 Injured

2 CASES

Mixing Operation

7 Killed

60 Injured

1 CASE

Dust Collection System

58 Killed

144 Injured

7 CASES

Elevator/Bucket Elevator

9 Killed

43 Injured

"PHARMACEUTICAL INDUSTRY" IN USA

38 INJURED

6 KILLED

SAFETY CODES RELATED TO DUST EXPLOSION

Anumber of safety codes nowaddress the dust/vapour explosionpotential depending on the type of industry or operations. An illustrative example, are the National Fire Protection

Association (NFPA) codes:

NFPA 65, 480, 481	• Combustible metals and metal dusts
• Explosion protection systems	**NFPA 68, 69**
NFPA 91, 650, 654, 655	• Handling and conveying of dusts, vapour, and gases
• Prevention of sulphur fires and explosions	**NFPA 655**
NFPA 664	• Prevention of fires and explosions in wood processing and woodworking facilities
• EU directives describing what equipment and work environment with an explosive atmosphere	**ATEX Directive 99/92/EC**

CHECKLIST AUDIT

DUST EXPLOSION INSPECTION CHECKLIST

COMPANY: _____

TYPE OF COMBUSTIBLE DUST : _____

TYPE OF INDUSTRY : _____

TYPE OF OPERATION : _____

NO	ITEM	Y	N	NA	COMMENT
1	**FUEL DUST**				
a	Hazard assessment were done on all process involved.				
b	Combustible dust accumulation were monitored and measured				
2	**IGNITION**				
a	Electrical and mechanical preventive maintenance program were executed thoroughly				
b	Any ignition source are distanced from LEV or Vacuum				
c	Electrical System including facility lighting inspected to ensure no open wire or leakage.				
d	Static Electricity are controlled and eliminated				
e	Action taken to control the discharge of lightning strikes				
f	All the equipment were connected to grounding wire				
g	Action were taken to control hot works, welding or cutting in dust explosion hazard area				
3	**DISPERSION**				
a	Efficiency of housekeeping program				
b	Conveyor transfer points were monitored and action taken to minimize dust accumulation				
c	Equipment vibration monitored and prevented if necessary				
d	Efficiency of dust collection system				
e	Misting were use where necessary				
f	Upset condition: means taken to minimise dust accumulation before start up				
4	**ENGINEERING CONTROL**				
a	Local exhaust ventilation systems were installed and maintained				
b	Covering boxing in beams and other structural steel with horizontal surfaces				

c	Efficiency of ventilation				
d	Concealed space including ceiling, crawl spaces and attics were perfectly covered to prevent from dust accumulation.				
5	**FIRE / EXPLOSION PROTECTION**				
a	Fire protection system were installed and tested				
b	Fire extinguishers are available and placed at proper area.				
c	Fire extinguishers are maintained: Pressure and expire date.				
d	Efficiency of explosion venting / isolation				
e	Spark / Ember detection and extinguishing system were installed and tested				
f	Special fire protection system were installed to minimize the generation of dust clouds				
6	**GENERAL**				
a	Specific safe operating procedure for process involving dust explosion				
b	Workers were trained on dust explosion and refresher course were done				
c	Emergency Response System				
d	Combustible Dust Mitigation / Assessment Review				
e	Other work activities that may increase the hazard of combustible dust are controlled				
f	Fire / Dust explosion incident records				
g	Record keeping and corrective action				
h	Signage				
i	PPE				
	TOTAL				

Comment :

NAME : DATE :

SIGNATURE:

** Examination of dust explosion risk is not only limited to this checklist only.

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